MHSMP-91-04

MODIFICATION AND TESTING OF THE MC4043 JETTISON CUTTER COMPONENT OF THE B90 WEAPON SYSTEM

Steven G. Hallett

JANUARY 1991

Process Development
Weapon Systems Development
(B90)

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ABSTRACT

Performance testing of two different engineering development designs of the MC4043 Jettison Cutter component is described. Existing component rings are modified to accept Lexan inserts that serve to isolate the linear separation ordnance from the steel component substrate. The performance of the modified rings is compared to that of unmodified rings. Data obtained suggest that a similar principle could be used in subsequent Jettison Cutter designs that would improve overall ordnance performance and reduce component weight.

INTRODUCTION

The MC4043 Jettison Cutter of the B90 system is a component designed to explosively sever Kevlar straps thus disengaging the weapon from the deployed parachute. Type 6, copper precision linear-shaped charge (PLSC) has been selected as the baseline separation ordnance to perform this task. Figure 1 shows a typical example of an MC4043 test ring. Figure 2 depicts this assembly employed in a Kevlar strap separation test. Three MC4043 development assemblies have been tested in this configuration and have demonstrated the ability to satisfactorily separate the Kevlar straps. During these tests, however, it was noted that in several locations around an aluminum backing ring, residual jet penetration behind the separated Kevlar bundles was as low as 0.010 inch (Figure 3). This observation led to a concern that the jet penetration may be insufficient to reliably sever the Kevlar in all cases. These regions of low residual penetration were believed to have resulted from nonuniform PLSC jet formation since other areas of the backing ring demonstrated residual penetration in excess of 0.100 inch. For the purposes of these strap separation tests, the PLSC was mounted directly into the component steel ring as seen in Figure 4.

DISCUSSION

Extensive experimentation at Pantex has recently identified Type 6 PLSC jet penetration performance to be dramatically influenced by the degree of confinement applied.(1) Tests suggest that low shock impedance materials may provide a better confinement environment for Type 6 PLSC than steel, especially with regard to jet penetration uniformity. This isolation apparently serves to shock decouple the PLSC from the steel ring thus reducing the probability of reflected shock interfering with jet formation processes. Computer modeling is currently underway at Sandia National Laboratories Albuquerque (SNLA) to examine this hypothesis.

Engineering development studies are also being conducted to identify confinement (tamping) materials that will potentially maximize PLSC performance while meeting all system requirements and compatibility/aging concerns. Presently, Lexan has been selected as a material that reasonably fulfills these needs. In general, the jet of a Lexan-confined segment of Type 6 PLSC will average nearly the same penetration depth as a steel confined part, but the standard deviation of the groove depth will decrease by about a factor of 4.(2) It is believed that low impedance Lexan confinement of PLSC within the MC4043 ring will significantly reduce regions of poor jet formation and consequently improve overall strap separation capability.

EXPERIMENTAL

In order to quantitate the jet penetration depth and uniformity resulting from MC4043 experimental rings, assemblies such as the one shown in Figure 5, involving a 6061-T6 aluminum target ring, are tested. This configuration yields more complete jet penetration information about the circumference of the ring than intermittently situated Kevlar bundles. In all cases, the PLSC is initiated using low-energy, CP flying plate detonators at the specified standoff of 0.080 inch.

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1. S. G. Hallett, "Assessing the Influence of Selected Variables Type 6 Precision Linear-Shaped Charge Performance," MHSMP-90-01, Mason & Hanger - Silas Mason Co., Inc., Pantex Plant, Amarillo, Texas (January 1990).

2. S. G. Hallett, Work to be published, "The Effect of Confinement on Jet Penetration Performance of Type 6 Precision Linear-Shaped Charge," MHSMP Report (1990).

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PLSC jet penetration into the target is measured ultrasonically, providing approximately 250 points/test to characterize the resulting groove (Figure 6). The data obtained are reduced to a mean penetration value and a corresponding standard deviation from the mean. The data from all tests are plotted and compared.

The experimental plan consisted of test firing two MC4043 development assemblies, as originally designed, with the PLSC mounted directly into the steel ring and two MC4043 rings modified to accommodate a fabricated Lexan insert (Figures 7 and 8). Diagrammatic representations of the modifications can be seen in Figures 9 and 10. The insert was held in place by four nylon screws passing through the Lexan and into the steel ring. All test shots were assembled so that the operational standoff of the PLSC from the target ring was in the 0.105-0.115 inch range. In the original ring design this feature was achieved using brass standoff pins. In the Lexan insert design it was achieved by machined Lexan standoff rings (Figure 11). The standoff rings hold the PLSC firmly within a precisely milled channel in the Lexan insert (Figure 12). They are attached to the Lexan insert with nylon screws at 30° intervals.

In the normal component application, a 0.005-inch-thick stainless steel band is laser-welded over the open PLSC standoff cavity to provide a hydrostatic seal (Figure 13). This operation was also performed in three of the four test assemblies. There was, however, no sealing requirement for these tests; the steel band need only be present to simulate the weapon application. Since the band material supplied for the original MC4043 design was 0.5-inch wide, it could not be welded on both sides; the Lexan insert took up the full half inch of band width. On one of the Lexan assemblies the band was therefore repositioned farther to one side and welded only along that edge (Figure 14). The other Lexan assembly (Figure 15) was left unbanded primarily due to tolerance stackups. (The aluminum target would not fit over the ring with a band in place.)

RESULTS

The four assemblies were test-fired and the Type 6, copper PLSC jet penetrations into the targets were measured. The results of the experiment can be seen in Table I. The coreload for all PLSC parts was nominally 29 gr/ft.

Table I. Type 6 Copper PLSC Performance in MC4043 Ring Configurations

Ring No.	Coreload (gr/ft)	Confinement	Stainless Steel Band	Mean Penetration (inches)	Standard Deviation (inches)
4	28.3	steel channel	yes	0.128	0.047
11	29.2	steel channel	yes	0.149	0.031
3	28.7	Lexan insert	yes	0.154	0.009
10	29.6	Lexan insert	no	0.166	0.014

A graphical presentation of the data used to calculate the means and standard deviations listed in the table can be found in Figures 16 and 17. Viewed in this format, the difference in performance between the steel ring tests and the Lexan insert tests is striking. The data collected indicate that the Lexan insert assembly may have only marginally outperformed the steel ring in terms of mean jet penetration, but the major advantage of this design indeed appears to be realized in improved penetration uniformity. The standard deviation of jet penetration decreases from about 0.040 inch for the steel assemblies to about 0.010 inch for the Lexan insert assemblies. There also appears to be a slight increase in jet penetration when the steel band is absent, however, a single test does not allow statistical comment in this regard.

An additional benefit derived from the Lexan insert design is an overall reduction in mass of the MC4043 component. The original component ring weighed about 2.55 kg; the weight of the ring with the Lexan insert in place is reduced to about 2.18 kg. Replacing steel volume with Lexan appears to have no visually detectable adverse affect on structural integrity of the ring (Figure 18). In fact, the Lexan insert remains intact within the ring during the tests with little evidence of perturbation. The only evidence of ring deformation is seen in the detonator region where slight flaring occurred (Figure 19).

Additional testing is planned to investigate the Kevlar strap separation capability for Lexan insert assemblies. These tests will be completed presently.

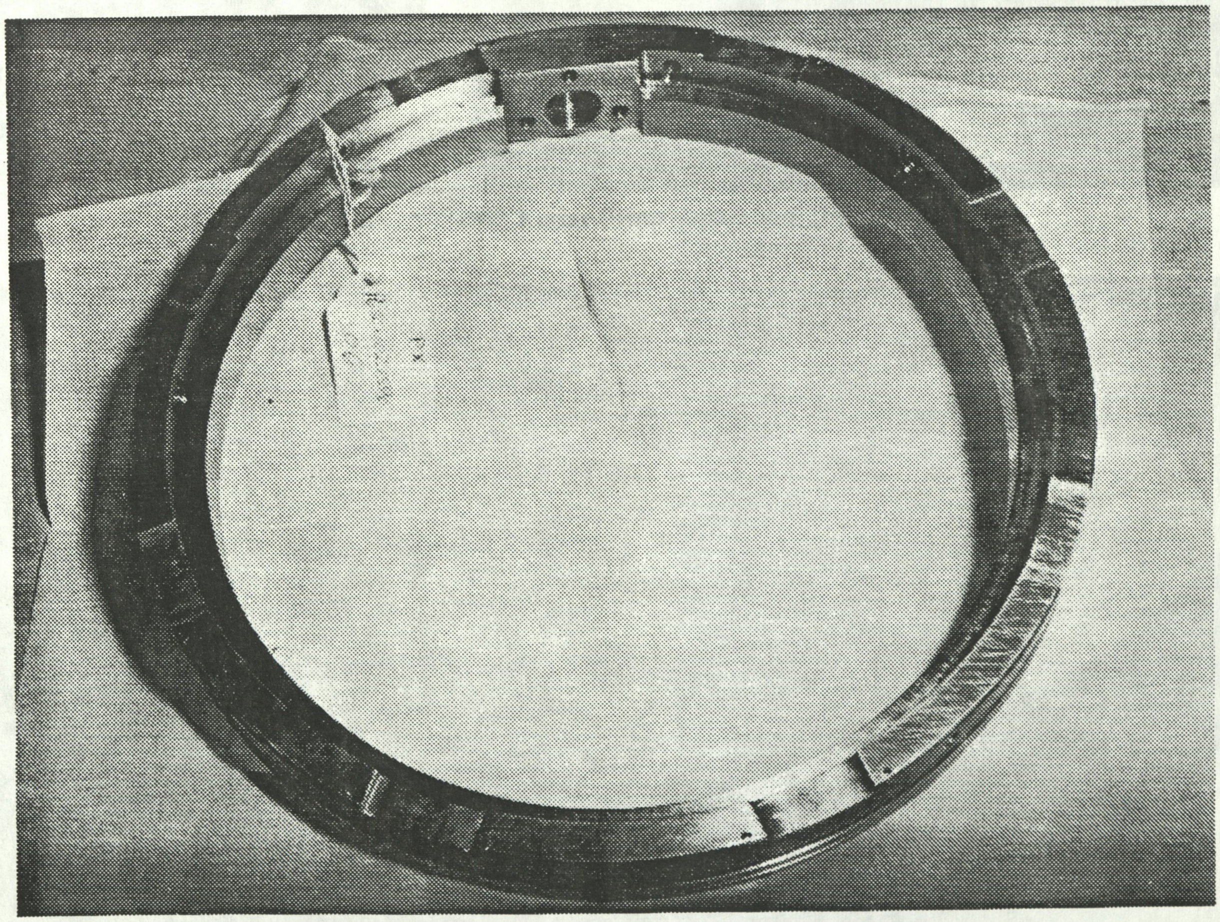

Figure 1. Typical MC4043 Jettison Cutter Test Ring

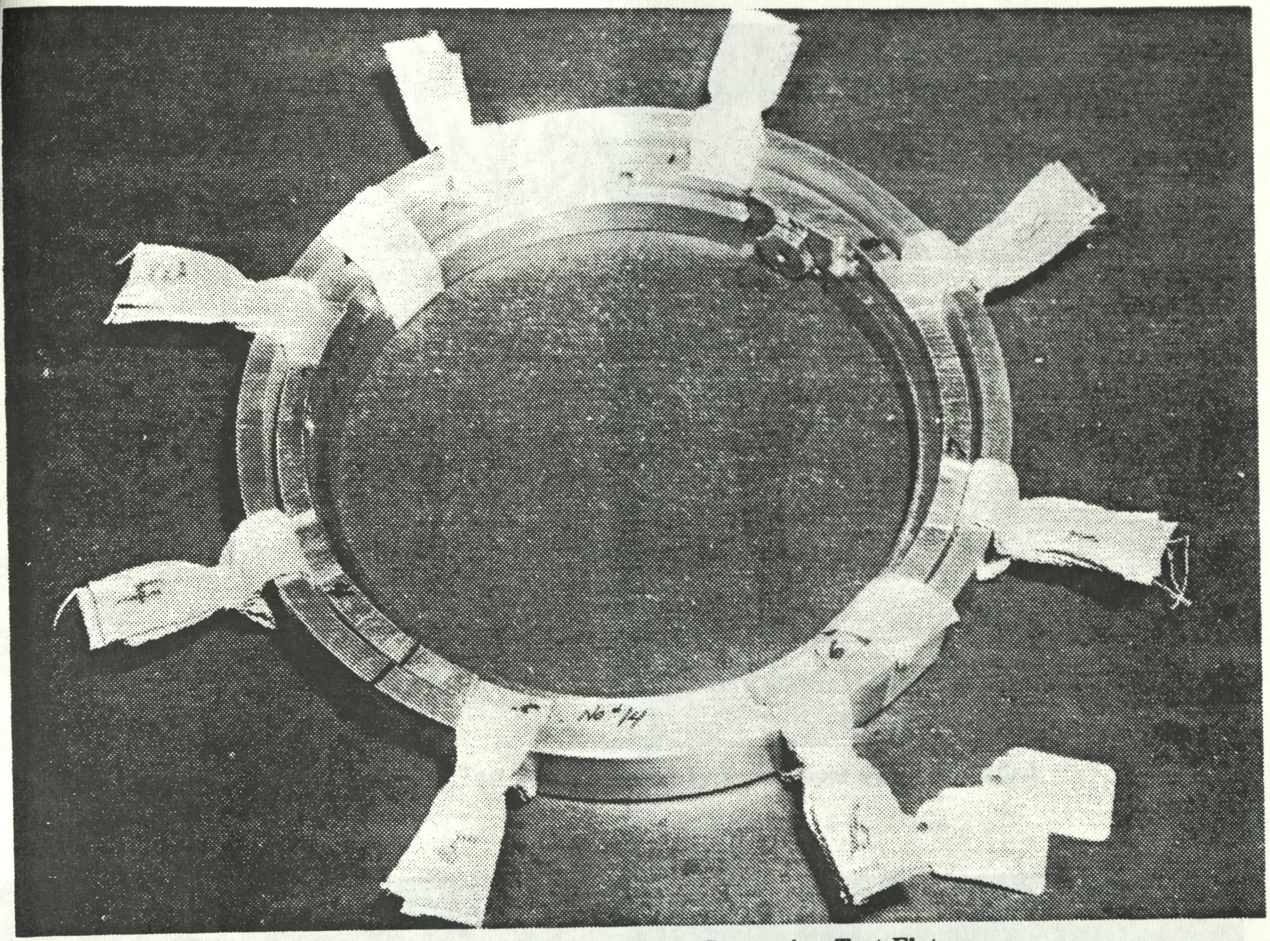

Figure 2. **MC4043 Kevlar Strap Separation Test Fixture**

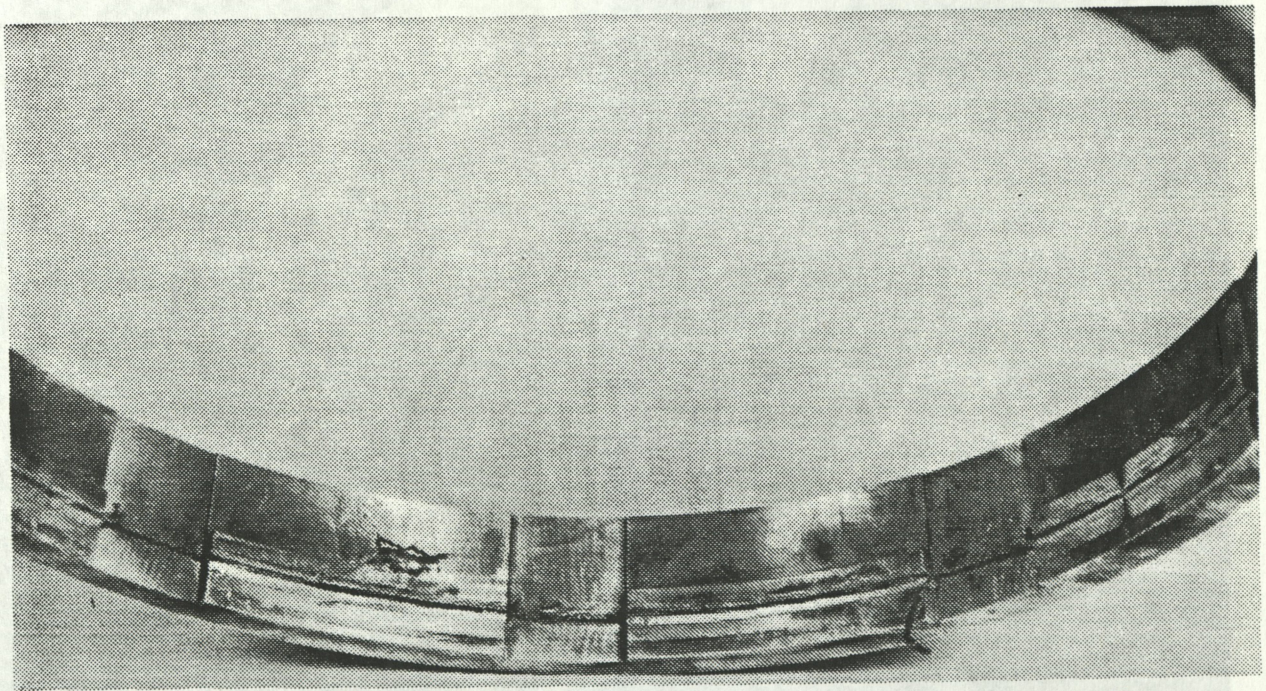

Figure 3. **Aluminum Backing Ring Showing Regions of Residual Jet Penetration in Strap Recesses**

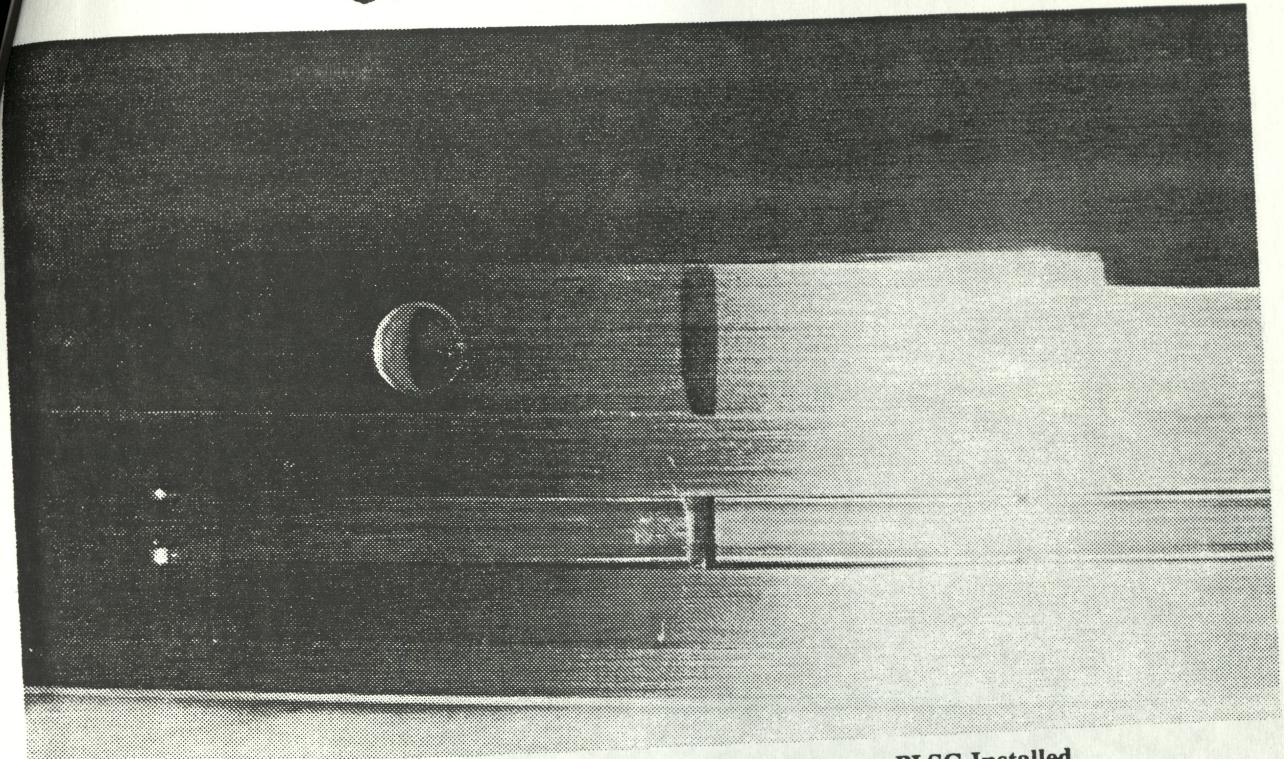

Figure 4. MC4043 Test Ring Showing Type 6 Copper PLSC Installed

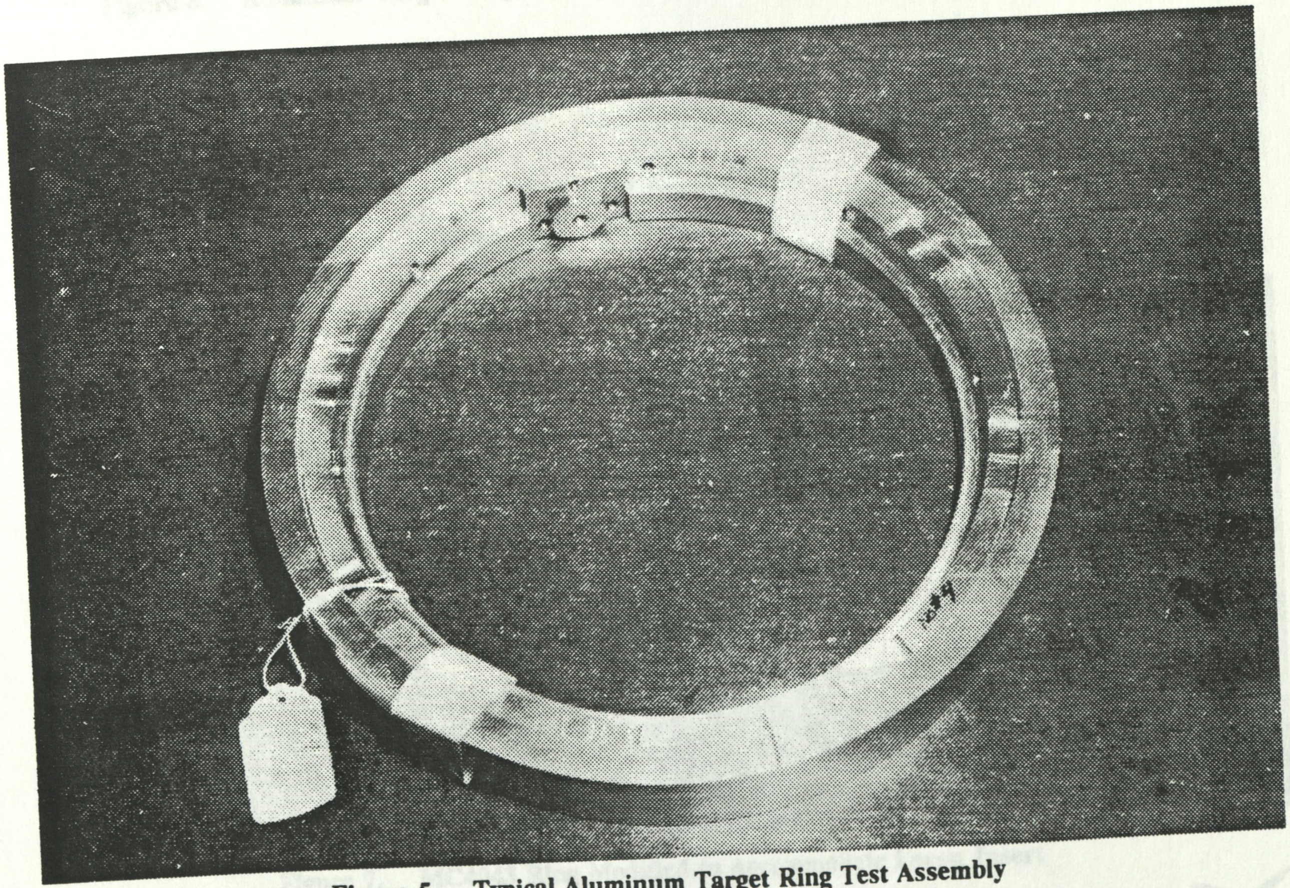

Figure 5. Typical Aluminum Target Ring Test Assembly

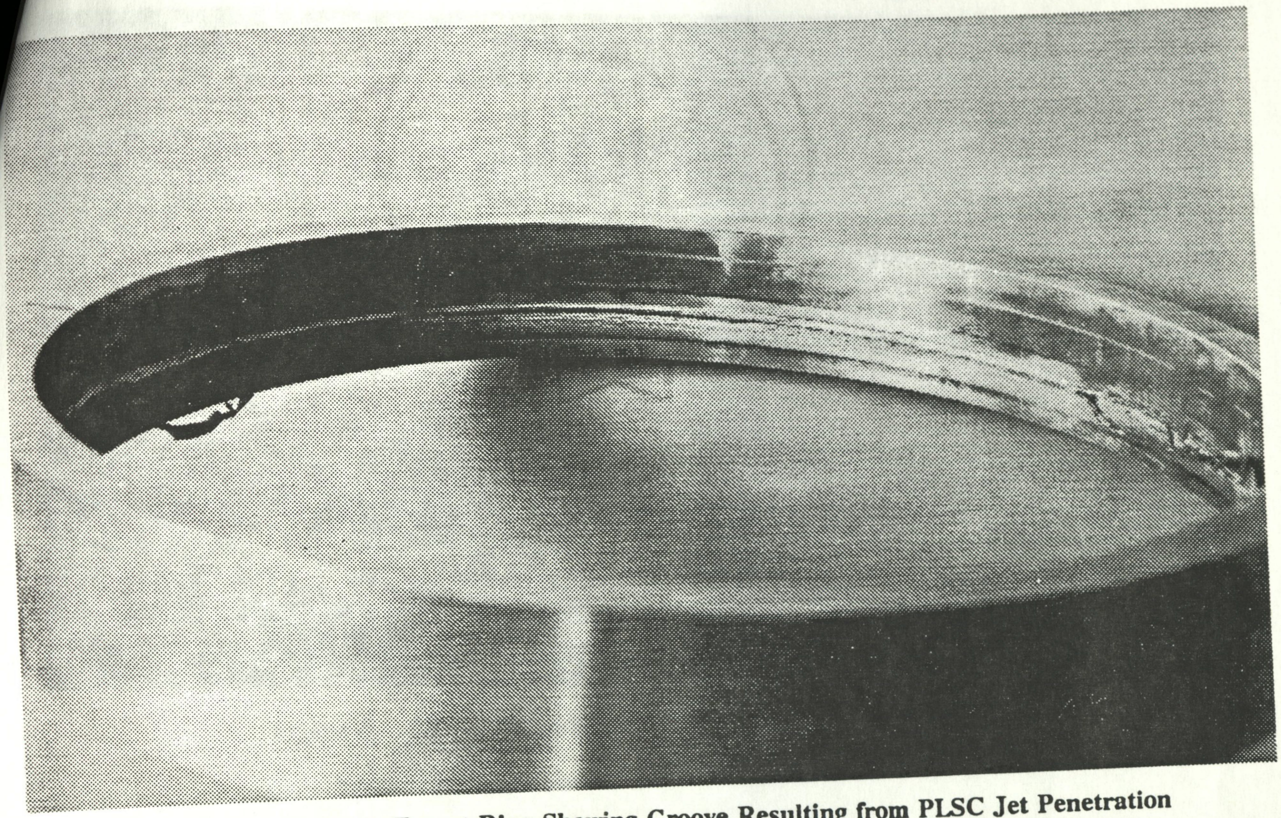

Figure 6. Aluminum Target Ring Showing Groove Resulting from PLSC Jet Penetration

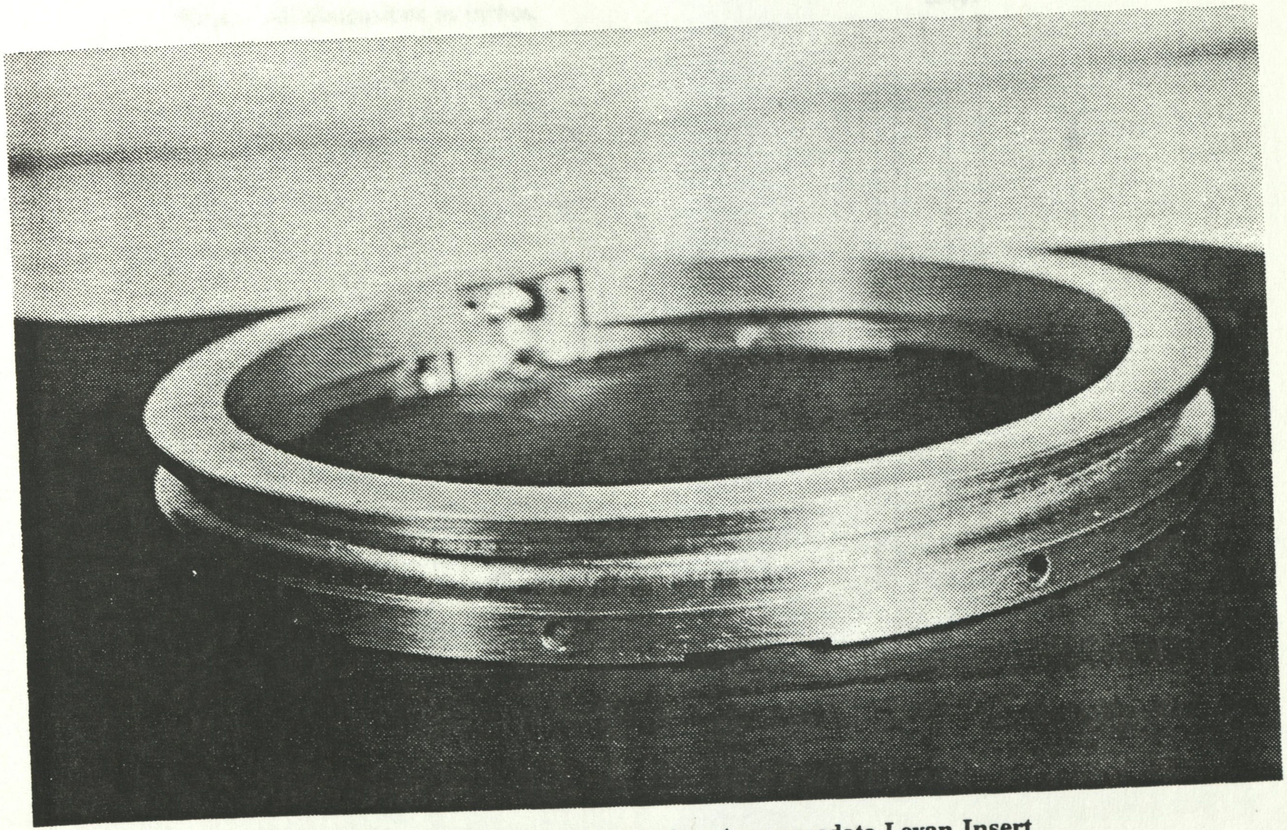

Figure 7. MC4043 Ring Modified to Accommodate Lexan Insert

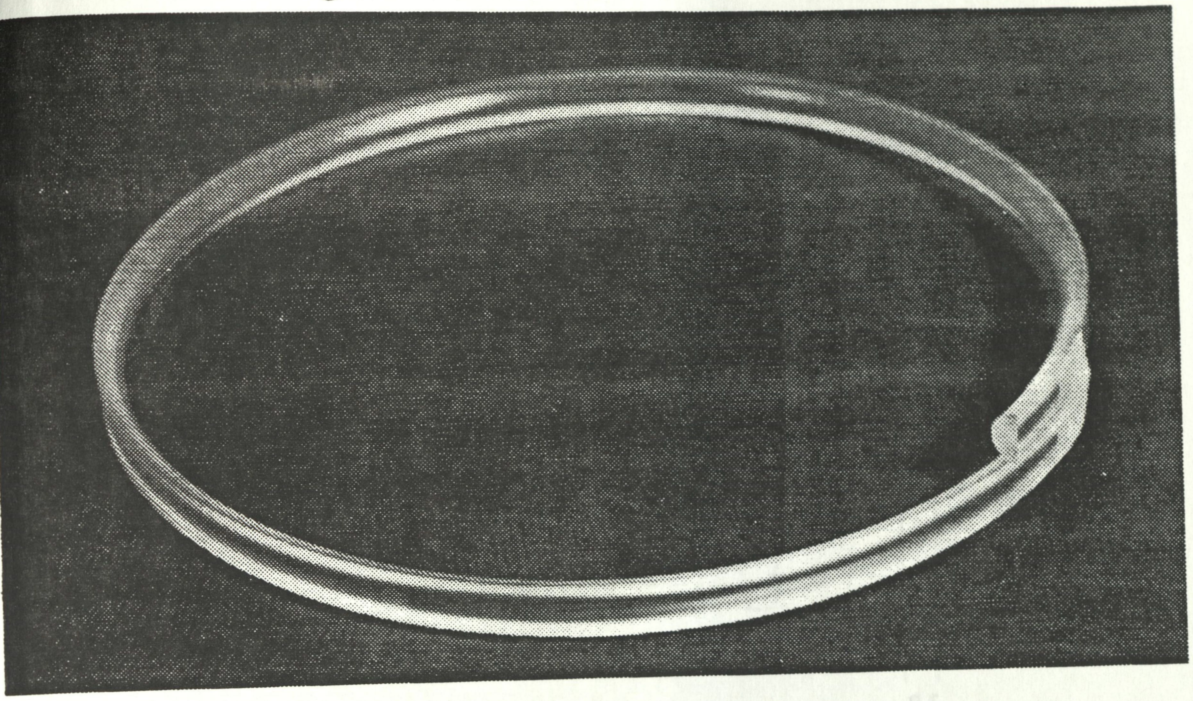

Figure 8. Lexan Insert for Use in Modified MC4043 Test Ring

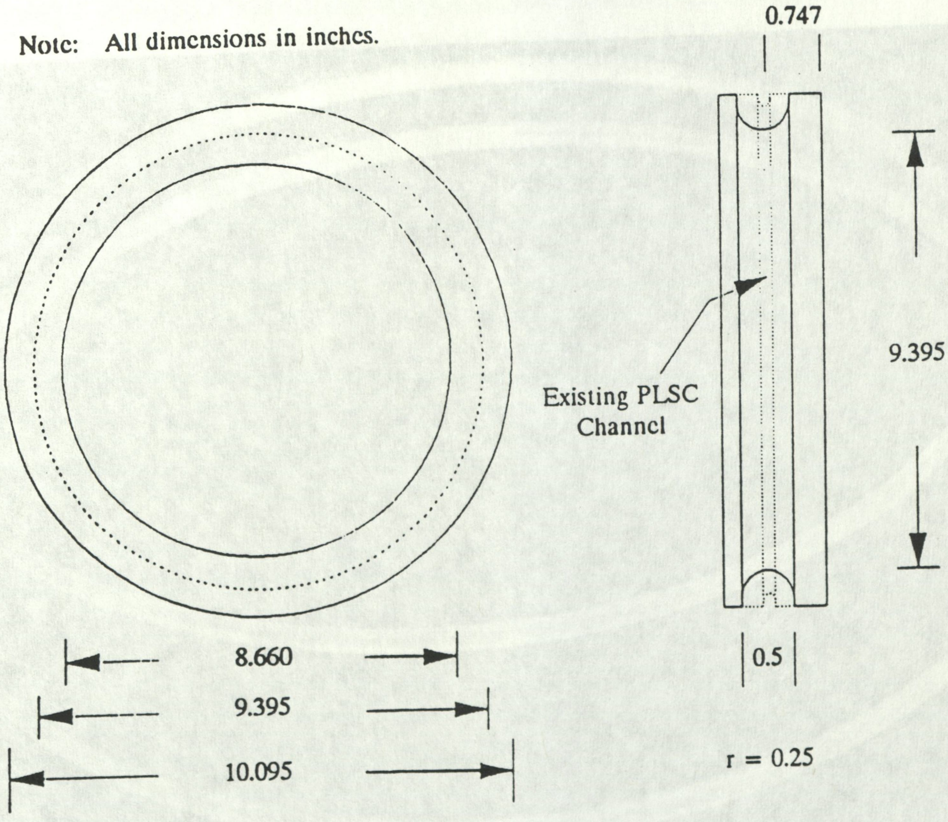

Figure 9. MC4043 Modification Required to Accept Lexan Insert Ring

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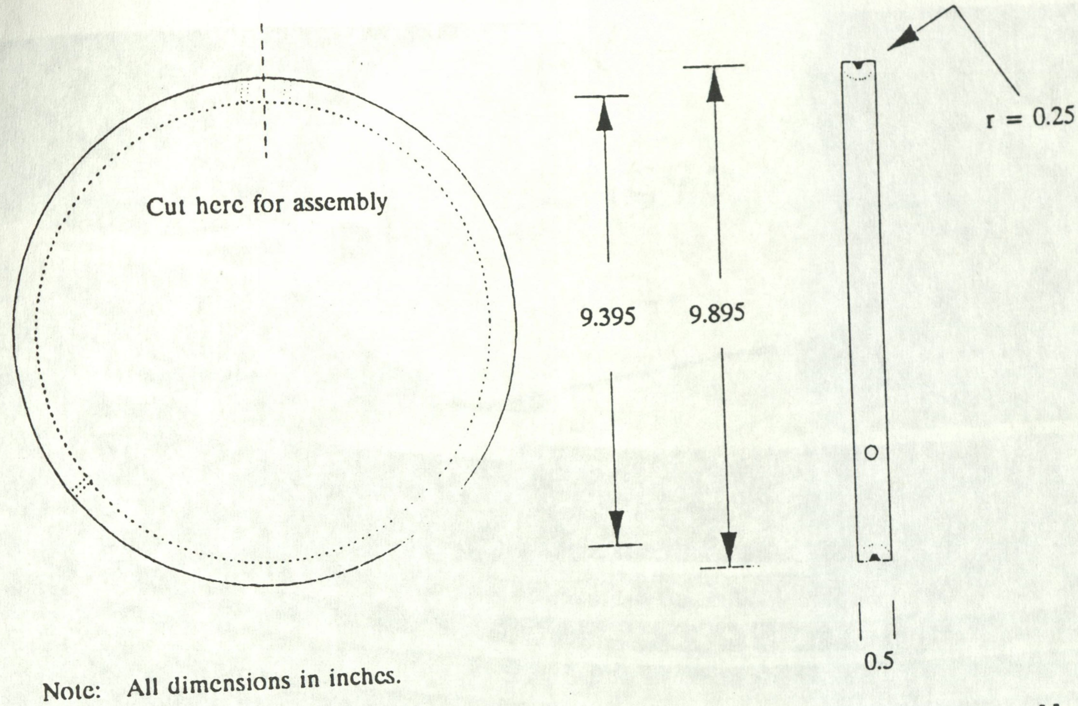

Figure 10. Lexan Insert Ring Fabricated for Modified MC4043 Test Ring Assembly

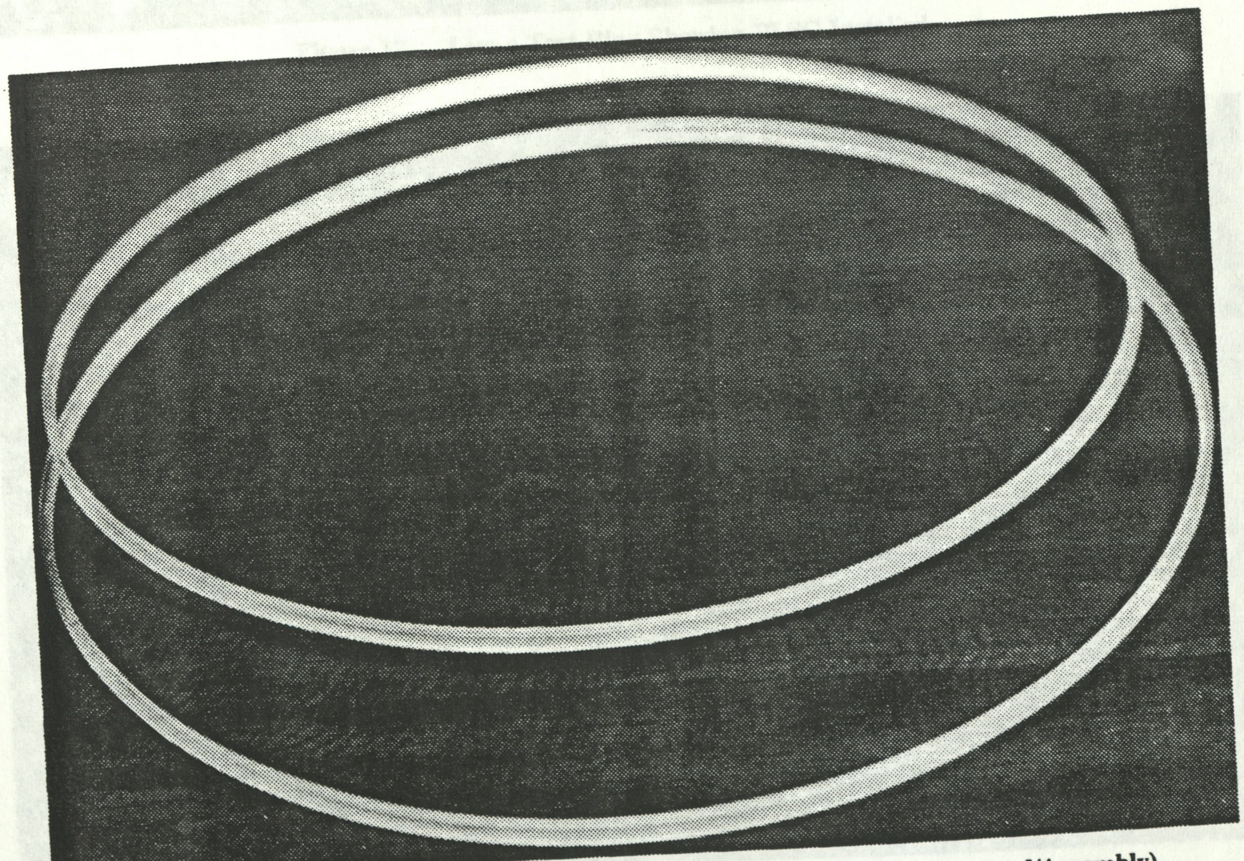

Figure 11. Machined 0.100-inch-thick Lexan Standoff Rings (Two Required/Assembly)

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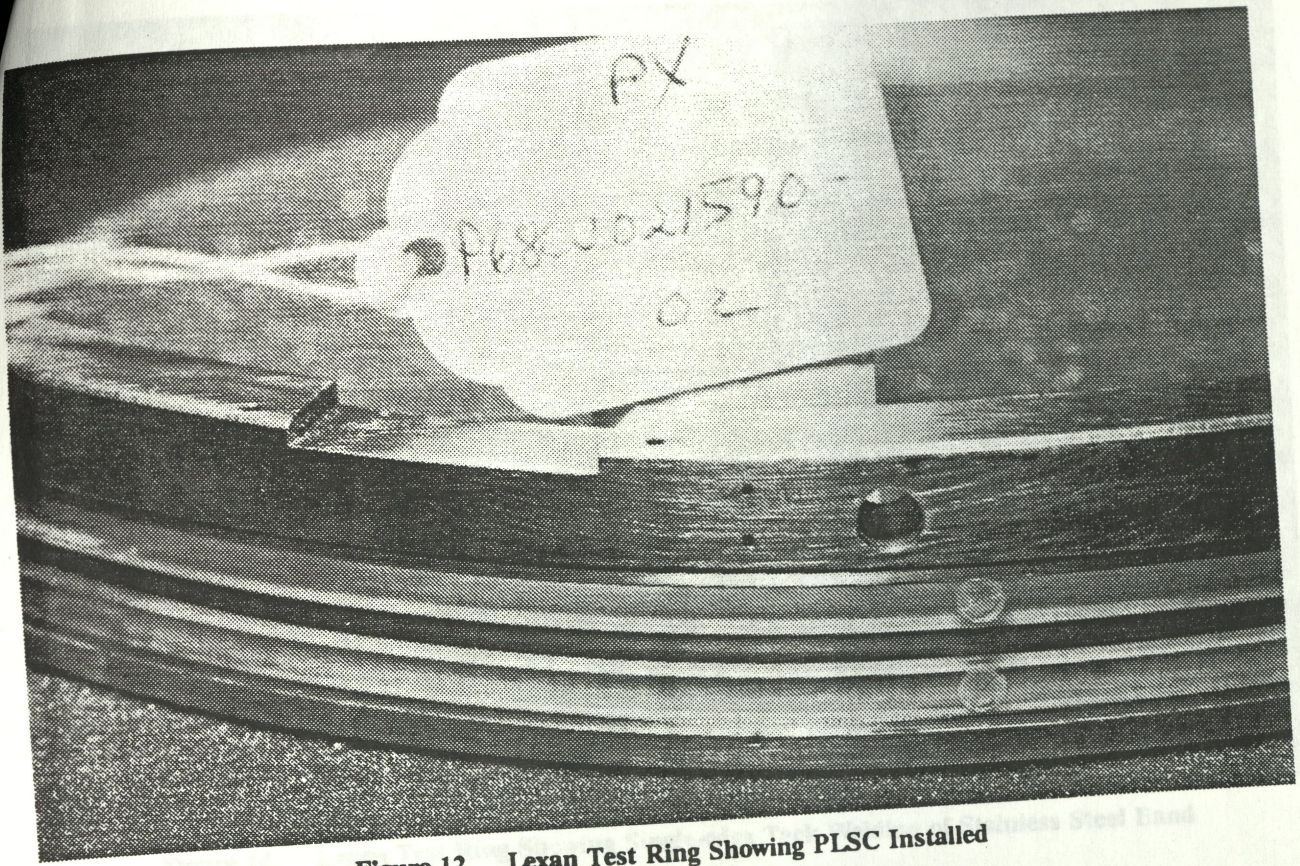

Figure 12. Lexan Test Ring Showing PLSC Installed

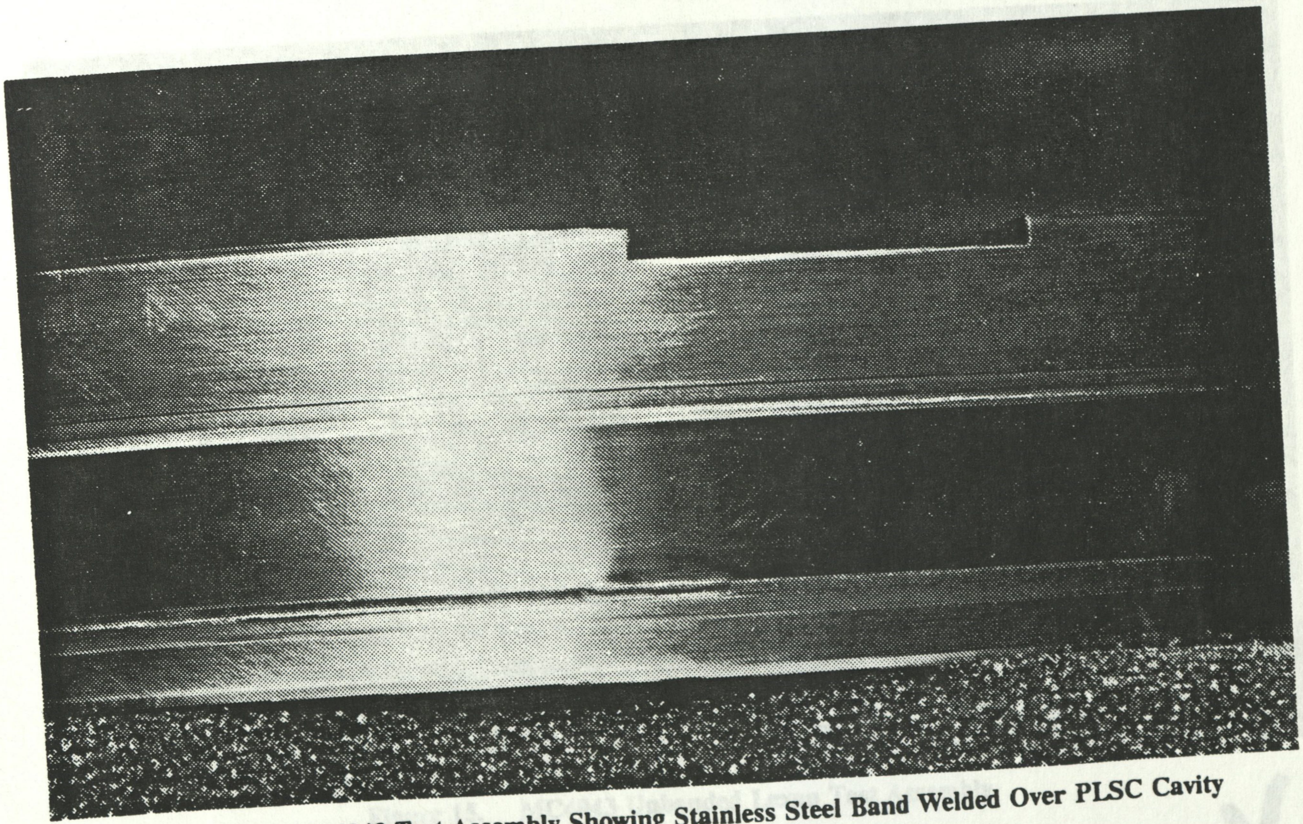

Figure 13. MC4043 Test Assembly Showing Stainless Steel Band Welded Over PLSC Cavity

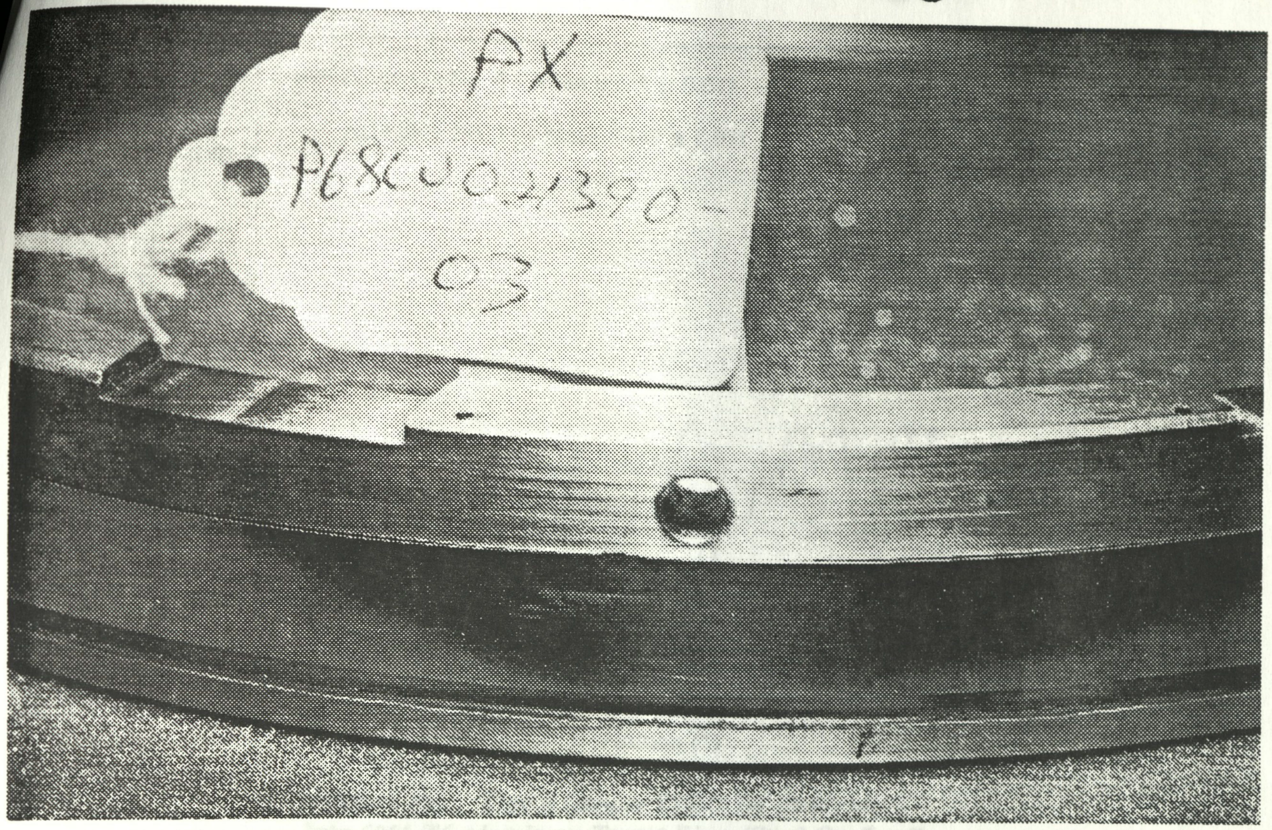

Figure 14. Lexan Test Ring Showing Single-edge Tack Welding of Stainless Steel Band

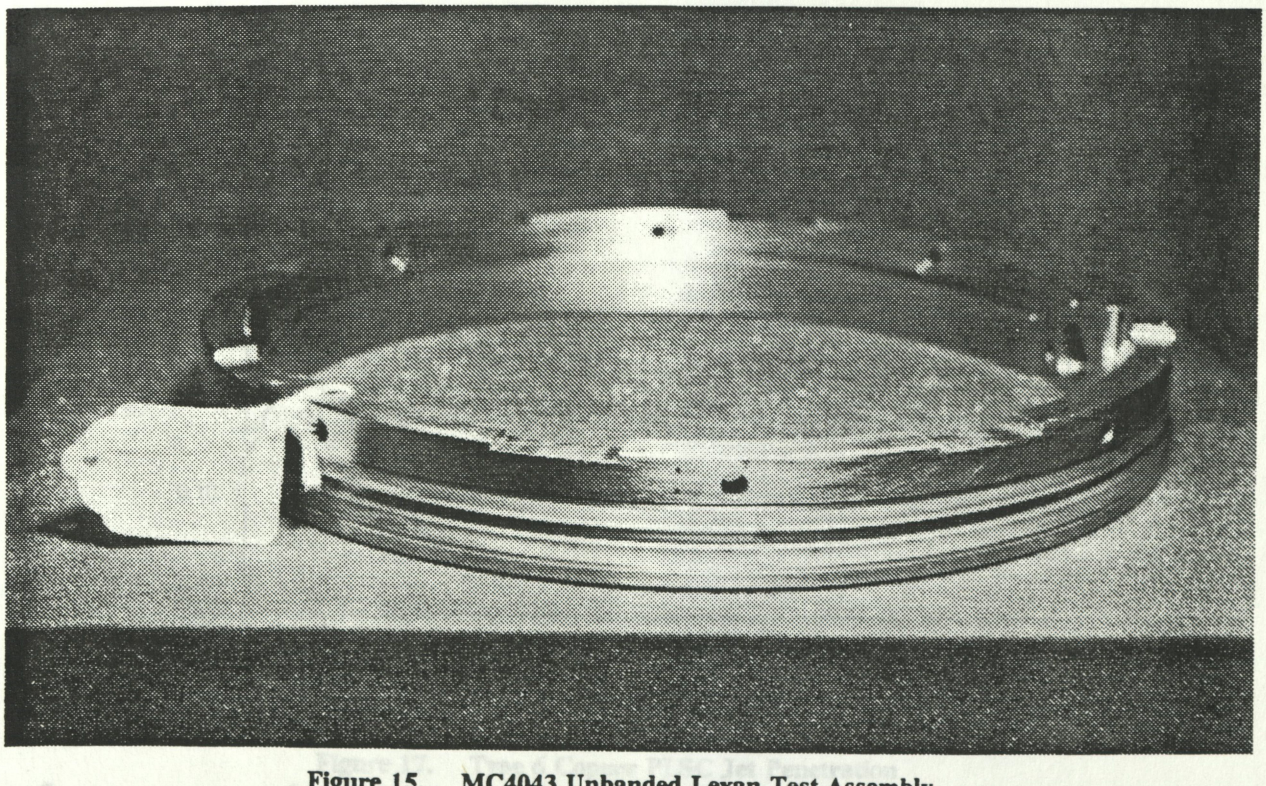

Figure 15. MC4043 Unbanded Lexan Test Assembly

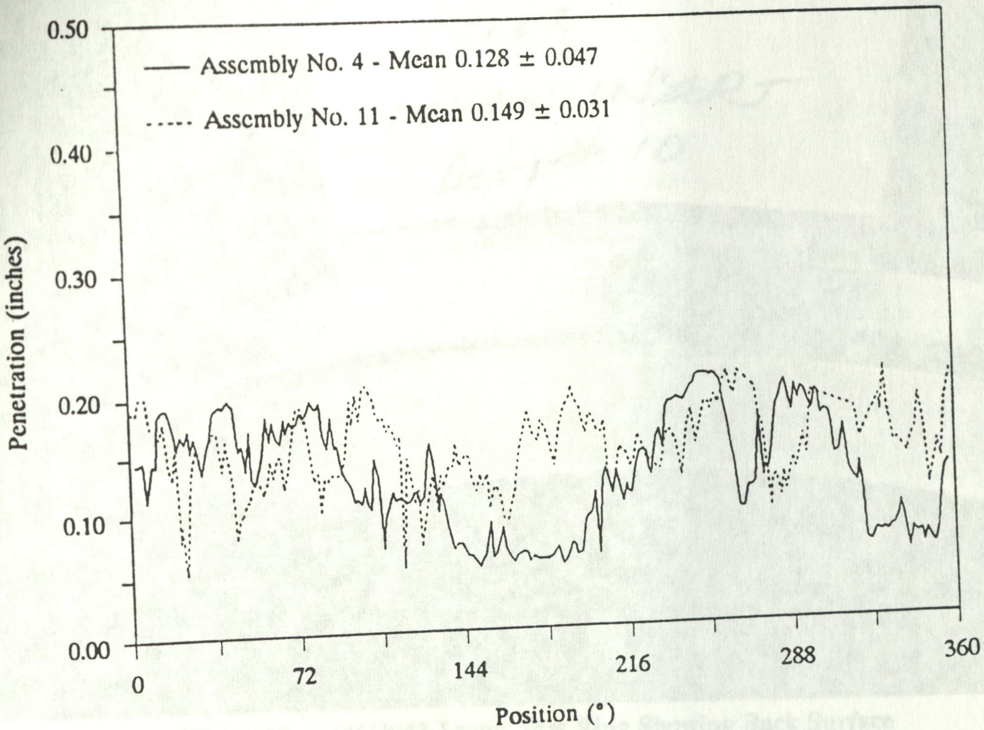

Figure 16. Type 6 Copper PLSC Jet Penetration Into 6061-T6 Aluminum Target Ring (Steel Confined)

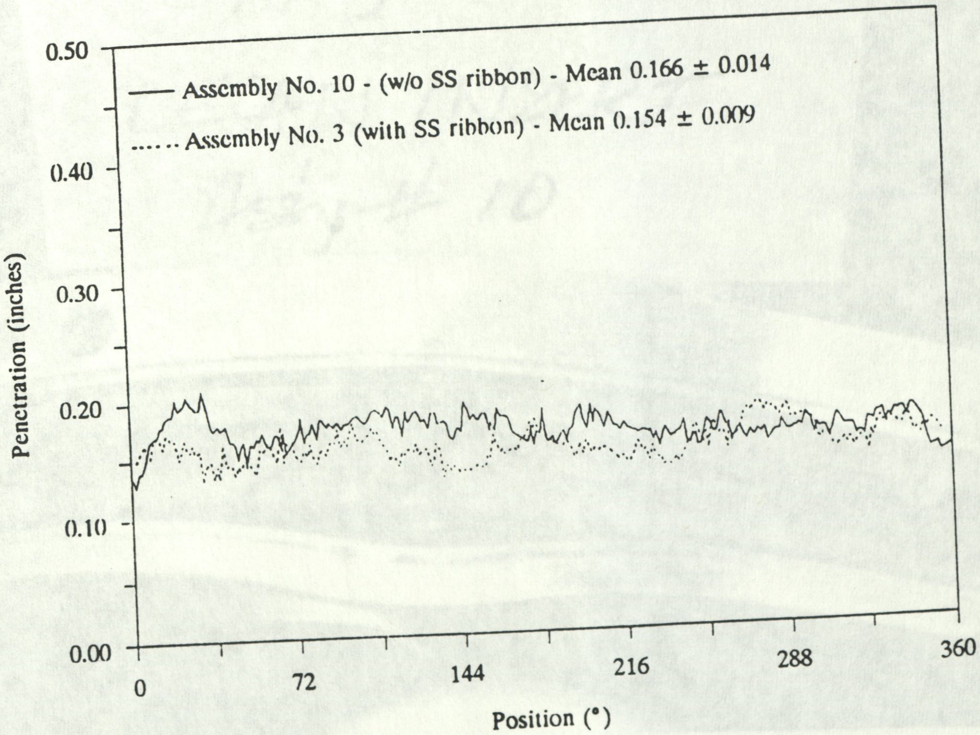

Figure 17. Type 6 Copper PLSC Jet Penetration Into 6061-T6 Aluminum Target Ring (Lexan Confined)

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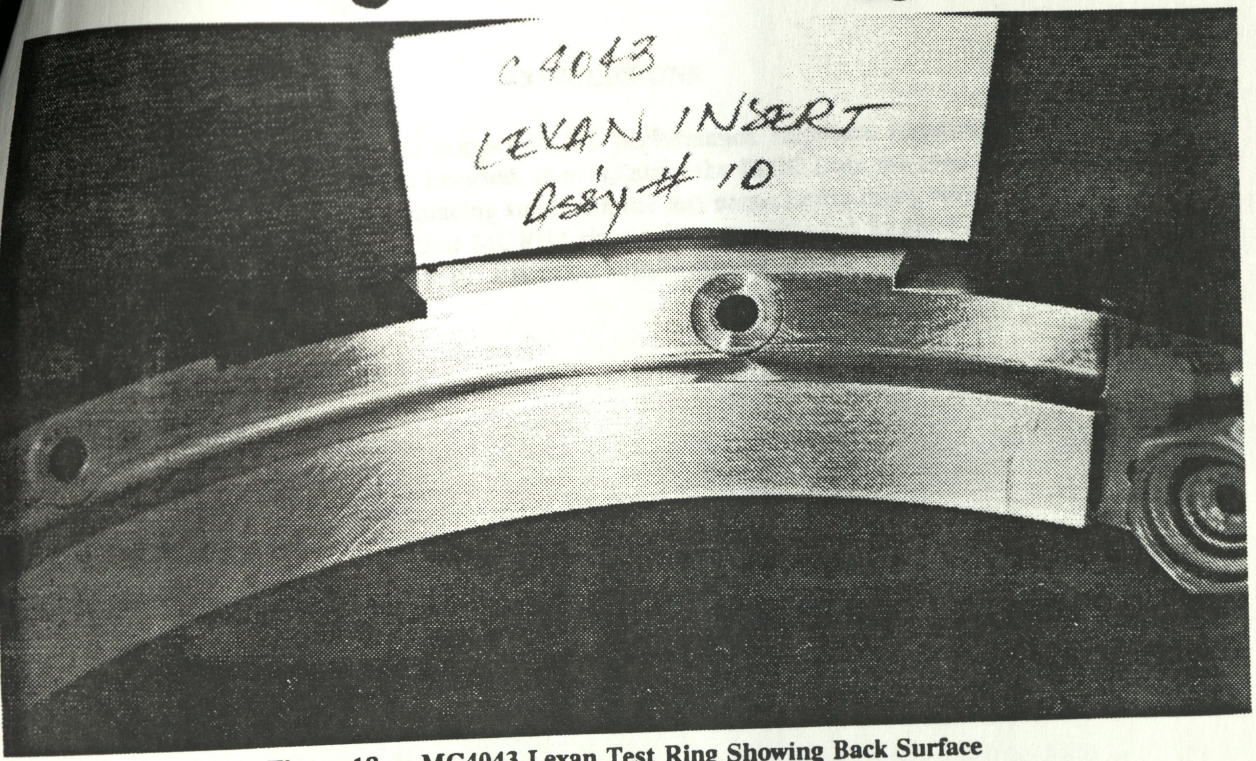

Figure 18. MC4043 Lexan Test Ring Showing Back Surface to be Free of Fracture or Visual Deformation

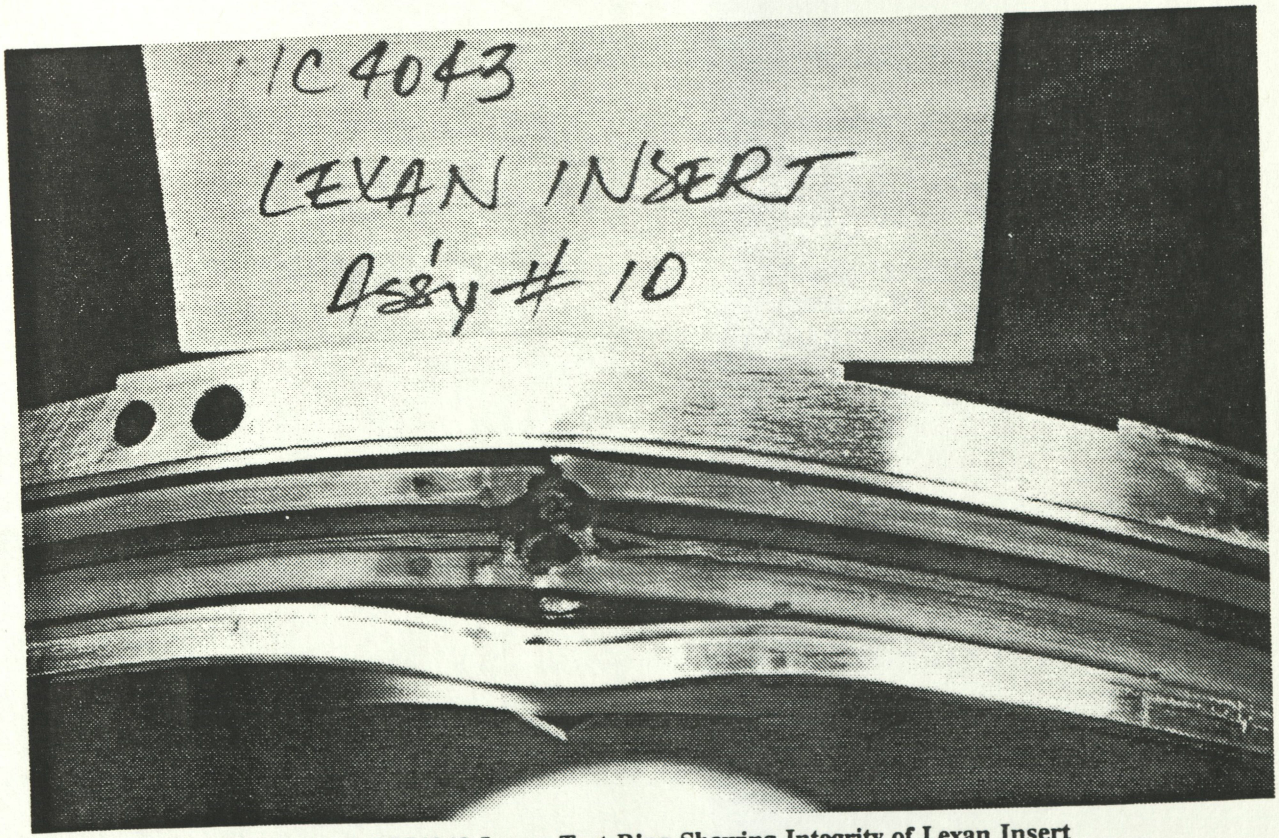

Figure 19. MC4043 Lexan Test Ring Showing Integrity of Lexan Insert and Ring Flaring in Detonator Region

CONCLUSIONS

Data obtained indicate that Type 6 copper PLSC performance improves significantly in terms of jet penetration uniformity when Lexan is inserted, thus isolating the PLSC from the steel ring. In addition, the mass of the ring may be reduced by replacing steel with the less dense Lexan insert without apparent sacrifice of structural integrity. It is believed that MC4043 rings can be modified to accept Lexan inserts within the bounds of current design specifications; no structural reinforcement of ring is necessary for this purpose.

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